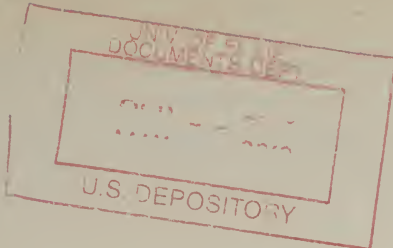


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United States Department of Agriculture,

BUREAU OF CHEMISTRY—CIRCULAR No. 52.

H. W. WILEY, Chief of Bureau.

EXTRACTS FROM THE PROCEEDINGS OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS, 1909.

(An advance circular giving the recommendations of referees as adopted and other action affecting the work of 1910, together with the officers, referees, and committees appointed.)

REPORTS ON THE RECOMMENDATIONS OF REFEREES.

COMMITTEE A.—J. K. HAYWOOD, CHAIRMAN.^a

(Nitrogen, potash, phosphoric acid, soils, inorganic plant constituents, insecticides, and water.)

PHOSPHORIC ACID.

It is recommended—

(1) That for paragraph (a), page 1, Bulletin 107, Revised, the following be substituted:

(a) *Ammonium citrate solution.*—Dissolve a convenient quantity of commercial citric acid in four times its weight of water; add commercial ammonium hydroxid until a faint odor of ammonia persists when the solution is hot; cool and complete the neutralization as follows: Select four Nessler's jars in which equal columns occupy equal heights, add a carefully purified litmus solution, or preferably a solution of azolitmin, from a burette, taking care that precisely the same volume of indicator is placed in each of the four jars. Fill two of the jars to the 50 cc mark with distilled water neutral to the indicator; add to each of the remaining jars from a burette 2.5 to 5 cc of the citrate solution to be neutralized, and fill to the 50 cc mark. Place the jars containing the indicator and water alone one in front of the other; add to one a drop of strong citric acid solution and to the other a drop of strong ammonium hydroxid. By looking through both of these jars the neutral tint of the indicator is observed for comparison. Arrange the jars containing the ammonium citrate to be tested in a similar manner, and compare the colors; add citric acid or ammonium hydroxid until the tint produced can not be distinguished from that observed through the pair of jars used for a standard neutral color. It is recommended that the pairs of jars be placed in a box divided into compartments. Narrow slits through each compartment will aid in the comparison of the tints. Bring the neutralized citrate solution to a specific gravity of 1.090, at 20° C., testing by means of a Westphal balance or by a pyknometer.

^a In the absence of the chairman this report was presented by J. P. Street, Connecticut.

It was ordered that this method be further studied by the referee with a view to its consideration for adoption in 1910.

(2) That before the word "flask," in the second line, under "(4) Citrate-Insoluble Phosphoric Acid," page 3, the words "250 cc Erlenmeyer" be inserted.

After some discussion it was ordered that this recommendation be referred to the referee for 1910.

(3) That after the first sentence under the subject head just mentioned, paragraph (4) (a), fourth line, the following sentence be added: "The level of the water in the bath should be above that of the citrate solution in the flasks in which the digestion is carried out."

Approved and referred to the association for final action in 1910.

(4) That after the word "contents" in the eleventh line of the same subject head, page 3, the following be substituted: "through a paper resting on a cone, using suction in the filtration, and washing . . ."

Referred to referee for further trial with view to its adoption.

(5) That for the sentence "Wash thoroughly with water at 65° C." in the twelfth line under the same subject head, page 3, substitute the following: "Wash with water at 65° C. until the volume of the filtrate is about 350 cc, allowing time for thorough draining before adding new portions of water."

This matter was ordered referred to the referee for further study and action in 1910.

(6) That the association appoint a special committee to confer with experiment stations with the view to securing their cooperation in instituting culture experiments for determining the relative availability of the phosphoric acid in basic slags, this committee to make a report annually on the work undertaken and to present a complete summary of the results, and also to make appropriate recommendations concerning laboratory methods of examining basic slags after a period of five years.

Adopted.

(7) That the Wagner method for estimating the availability of phosphoric acid in slags be brought up for provisional adoption at the next meeting.

Adopted.

NITROGEN.

It is recommended—

(1) That in Bulletin 107, Revised, page 8, line 4, after the word "time" the following be inserted: "Allow the flask to stand without heat for not less than six hours, or for a shorter time, with shaking at regular intervals,^a the intention being to secure complete solution of the nitrate."

Lost.

(2) That in Bulletin 107, Revised, page 8, under "(3) Determination," line 5, after the word "and" the following be inserted: "allow the flask to stand without heat for not less than six hours, or for a shorter time, with shaking at regular intervals,^a the intention being to secure complete solution of the nitrate."

Lost.

^a When the nitrate nitrogen present exceeds 1.50 per cent the six-hour interval is recommended.

POTASH.

It is recommended—

(1) That Drushel's modification of the cobalti-nitrite method for the determination of potash be given a further trial during the ensuing year.

Adopted.

SOILS.

It is recommended—

(1) That the modified J. L. Smith method for total potassium be made an official method of this association, and that the clauses "and transfer to a filter" and "after washing free of chlorids" in this method be replaced by the following sentence: "After washing four or five times by decantation with hot water, throw on the filter and wash well, 250 to 300 cc of wash water being sufficient."

Approved and referred to the association for final action in 1910.

(2) That the magnesium nitrate method for total phosphorus be made an official method of this association.

Approved and referred to the association for final action in 1910.

(3) That the sodium peroxid fusion method for total phosphorus be made an official method.

Approved and referred to the association for final action in 1910.

(4) That the Drushel modification of the cobalti-nitrite method, in connection with the J. L. Smith fusion method, be tested by the association the coming year as a method for total potassium.

Adopted.

WATER.

It is recommended—

(1) That the methods for mineral, sanitary, technical, and irrigation water analysis, collected and tested by the referee and associate referee this year, be printed for criticism of the members, with a view to their adoption next year as provisional methods of the association.

Adopted. (Detail of these methods follows Report of Committee A, p. 4.)

INSECTICIDES.

It is recommended—

(1) That the modification proposed by the referee (Method III) for total arsenic oxid in London purple be given a further trial in comparison with Method I.

Adopted.

(2) That Method II for total arsenious and arsenic oxids in London purple be dropped from the methods of analysis. (See Bul. 107, Revised, p. 29.)

Adopted.

(3) That the provisional method for total arsenic oxid in lead arsenate be adopted as official. (Bul. 107, revised, 239 (d.)

Approved and referred to the association for final action in 1910.

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(4) That further study be made of methods for the determination of total lead oxid and water-soluble lead and arsenic oxids in lead arsenate.

Adopted.

(5) That Method I (precipitation) for soda lye be adopted as official. (Bul. 107, Revised, p. 31.)

Adopted.

(6) That the provisional hydrogen peroxid method for the determination of formaldehyde be changed under 2, line 2, to read "3 grams" instead of "3 cc" and adopted accordingly as an official method.

Adopted. [The following phrase (line 3, p. 33) should accordingly be omitted: "(the specific gravity of which has been previously determined.)".]

(7) That the provisional cyanid method for formaldehyde be changed to read as follows: Under 2, line 8, page 33, Bulletin 107, Revised, strike out "dilute formaldehyde solution" and insert the words "formaldehyde solution containing not over 2.5 grams of a 1 per cent solution or the equivalent" and the method as changed be adopted as official.

Approved and referred to the association for final action in 1910.

(8) That the provisional hydrogen peroxid method for the determination of total sulphur in sulphur dips be adopted as an official method. (Bul. 107, Revised, p. 34.)

Adopted.

(9) That a study be made of Gatehouse's method^a for the determination of chlorids in cyanids, with a view to its adoption as an official method.

Adopted.

METHODS FOR THE ANALYSIS OF WATERS.

(Collected by J. K. Haywood and W. W. Skinner, having been tested in the Water Laboratory, Miscellaneous Division of the Bureau of Chemistry.)

Sanitary Waters.

TOTAL SOLIDS.

Thoroughly shake the vessel containing sample and remove to a weighed platinum dish with a pipette 100 cc of the unfiltered water. Evaporate to dryness and heat to constant weight at 105° C.

LOSS ON IGNITION.

Ignite at a low red heat. Note odor and darkening of residue. Weigh and record loss on ignition.

NITRIC ACID.^b

Treat 100 grams of water with two drops of a saturated solution of sodium carbonate and evaporate to dryness on the water bath. Treat the residue with

^a Sutton's Volumetric Analysis, 9th ed., p. 201; U. S. Dept. Agr., Bureau of Chemistry Cir. 10, Revised, p. 6.

^b For the determination of nitric and nitrous acid, free and albuminoid ammonia, and oxygen consuming capacity, the methods as given in Mason's Examination of Water are followed in all their principal details.

2 cc of phenol-sulphonic acid (made by mixing 148 cc of pure sulphuric acid, 12 cc of water, and 24 grams of phenol), add about 25 cc of distilled water and then an excess of ammonium hydroxid. Transfer to a 100 cc Nessler jar, make up to 100 cc with distilled water, and compare the depth of the yellow color with that produced by treating different amounts of standard potassium nitrate (containing 0.01 mg of nitrogen as nitrate in each cubic centimeter) in the same manner. If more than 6 parts per million of chlorin are present add to the standards before evaporation an amount of chlorin (in the form of sodium chlorid) equivalent to the amount of chlorids present in the sample under examination.

NITROUS ACID.

Place 100 grams of the water in a 100 cc Nessler jar and treat with one or two drops of concentrated hydrochloric acid. Add 1 cc of sulphanilic acid (containing 1 gram in each 100 cc of water), followed by 1 cc of a solution of naphthylamin hydrochlorid (obtained by boiling 0.5 gram of the salt with 100 cc of water for ten minutes at constant volume) and thoroughly mix. Set aside for half an hour with other Nessler jars containing known amounts of a standard nitrite solution (containing 0.0001 mg of nitrogen as nitrite in each cubic centimeter), made up to 100 cc with nitrite-free water, and treated with hydrochloric acid, sulphanilic acid, and naphthylamin hydrochlorid in the manner just described. By comparing the depth of pink color in the known and unknown solutions the amount of nitrite is determined.

FREE AMMONIA.

Connect a large flask of about 1.5 liters capacity with an upright bulbed condenser by means of a rather large glass tube and soft, new, rubber-stopper connections. Place in this 5 cc of a saturated solution of sodium carbonate and 200 cc of ammonia-free water. Distil off in 50 cc Nessler jars until no more ammonia is shown. Add 500 grams of the water under examination and distil in 50 cc Nessler jars until ammonia ceases to be given off. About four or five jars are usually necessary. Nesslerize and compare the depth of color with that in other jars containing known amounts of a standard ammonium chlorid solution (0.01 mg of ammonia in each cubic centimeter), made up to 50 cc with ammonia-free water and nesslerized in the same manner.

TOTAL AMMONIA.

The same apparatus is used as that mentioned in the preceding paragraph. Place in it 200 cc of distilled water and 50 cc of alkaline permanganate solution (prepared by dissolving 200 grams of potassium hydroxid and 8 grams of potassium permanganate in 1,250 cc of water and boiling the whole down to about 1 liter). Distil off in 50 cc Nessler jars until ammonia ceases to come over. Add 500 grams of the water under examination and continue the distillation until ammonia ceases to come off. Six jars are in most cases sufficient. Nesslerize and compare with standards of known strength, as in the determination of free ammonia. From the total ammonia thus found subtract the free ammonia and the result is the albuminoid ammonia in 500 cc of water. [The many precautionary details of these two methods are not given, but can be found by consulting any good work on water analysis.]

OXYGEN CONSUMING CAPACITY.

Prepare two solutions: (1) A standard solution of potassium permanganate containing 0.3952 gram to the liter, each cubic centimeter of which has 0.1 mg of oxygen available for oxidation; and (2) a standard solution of oxalic acid containing 0.7875 gram of crystallized oxalic acid to the liter. Determine the value of the oxalic acid in terms of the permanganate by boiling 10 cc of oxalic acid solution and 200 cc of distilled water with 10 cc of sulphuric acid (1 to 3) and titrating the fluid while boiling with the standard permanganate solution to the appearance of a pink color. Treat 200 grams of the water in a porcelain dish with 10 cc of sulphuric acid (1 to 3) and bring to the boiling point. Run in standard permanganate until the water is quite red and continue the boiling for ten minutes, adding permanganate every now and then to

keep the pink color about the same. Cease boiling. Add 10 cc of standard oxalic acid, which destroys the color, and titrate with the standard permanganate to the appearance of a pink color. From the total number of cubic centimeters of permanganate used subtract the number of cubic centimeters equal to 10 cc of oxalic acid. The result gives the number of cubic centimeters of permanganate required for 200 grams of water.

CHLORIN.

To 100 grams of the water under examination add a few drops of phenolphthalein. If a red color is shown, titrate the carbonates thus indicated to bicarbonates by the addition of twentieth-normal acid potassium sulphate added at the rate of a drop every few seconds until the red color disappears.^a Add a few drops of potassium chromate (or add in the beginning if a red color is not shown with phenolphthalein) and titrate the chlorids with a standard solution of silver nitrate. If iodids and bromids are found, a correction of this figure is made equivalent to the amount of these constituents.

Mineral Waters.

TOTAL SALTS IN SOLUTION.

Allow the sample to stand until all sediment has settled. Remove from 100 to 250 cc and evaporate to dryness in a weighed platinum dish. Heat to constant weight at 105° C. It is sometimes also advisable to weigh after drying at 180° C.

LOSS ON IGNITION.

Ignite above residue to low redness, cool, and weigh.

SILICA.

Evaporate to dryness in platinum from 1 to 20 liters of water to which has been added hydrochloric acid, and dry the dish and contents at 120° C. for one hour. Take up the residue with hydrochloric acid and water, heat, filter, and wash thoroughly with hot water. This process takes out most of the silica. Evaporate the filtrate to dryness, and dry as before at 120° C., again take up in hydrochloric acid and water, heat, and filter. Make the filtrate to a definite volume, and use aliquot portions for the determination of iron, aluminum, manganese, calcium, magnesium, sulphuric acid, potassium, sodium, lithium, and phosphoric acid. Transfer the two residues to a crucible, ignite, blast, and finally weigh. Treat with hydrofluoric and sulphuric acids and evaporate on the water bath under a good hood; repeat the treatment if all silica is not volatilized. Dry carefully on hot plate, ignite, and blast. The difference between the two weights is the silica. The weight of the residue in the crucible, usually iron, is added to the determination of iron and albuminum.

IRON AND ALUMINUM.

Treat an aliquot portion of the silica filtrate with ammonium chlorid (to keep magnesia in solution) and heat to boiling. Add ammonium hydroxid, a drop at a time, until it can be very faintly smelled coming off from the solution. Boil the solution until the smell of ammonia has practically disappeared. filter, wash with hot water, dry, burn, and weigh as ferric oxid (Fe_2O_3) and alumina (Al_2O_3). Use the filtrate for the determination of calcium and magnesium.

IRON.

Treat an aliquot portion of the silica filtrate with 2 or 3 cc of concentrated sulphuric acid and evaporate to a sirupy consistency. Take up with water, reduce with hydrogen by the addition of zinc, filter, and determine the iron in the filtrate with standard potassium permanganate.

MANGANESE.

Treat an aliquot portion of the silica filtrate just as described above for iron and aluminum, so as to eliminate these two elements, and treat the

^a Cameron, Amer. Chem. J., 1900, 23: 481.

ammoniacal filtrate resulting with more ammonium hydroxid and a few drops of bromin, stir, and boil. Remove from the source of heat, cool slightly, and add a little more ammonium hydroxid and bromin. Repeat this process once or twice precipitating all the manganese as the oxid. Make the solution slightly acid with acetic acid, filter, and wash with hot water. Transfer the filter and contents to a crucible, ignite, and weigh as manganese tetroxid (Mn_2O_4).

CALCIUM AND MAGNESIUM.

(Not applicable in the presence of weighable amounts of phosphoric acid.)

Treat the filtrate from the iron and aluminum determination with ammonium hydroxid and ammonium oxalate and allow to stand over night. Filter off the liquid, wash twice with hot water by decantation, dissolve the precipitate in hydrochloric acid, and reprecipitate with ammonium hydroxid and a little more ammonium oxalate. Allow to stand over night and filter and wash on the same paper previously used. Dry the precipitate and transfer to a crucible, ignite and blast in the ordinary way, and finally weigh as calcium oxid. Evaporate the combined filtrates to dryness in platinum and drive off the major part of the ammonium salts by heating. Dissolve the residue in dilute hydrochloric acid and filter. Make the filtrate slightly ammoniacal, add enough sodium phosphate solution, a drop at a time, to precipitate all magnesium and 10 cc of concentrated ammonium hydroxid, drop by drop. Cover the beaker and allow to stand over night, filter, wash with 2.5 per cent of ammonium hydroxid until free from chlorids, dry, blast, and weigh as magnesium pyrophosphate.^a

SULPHURIC ACID, POTASSIUM, SODIUM, AND LITHIUM.

Treat another portion of the silica filtrate while boiling with hot dilute barium chlorid, and after standing, filter and wash the precipitated barium sulphate, dry, burn, and finally weigh in the usual manner.

Evaporate the filtrate to dryness and take up with water. Precipitate with a solution of barium hydrate or milk of lime and filter off the insoluble magnesium hydrate. Wash thoroughly with hot water the magnesium hydrate precipitate, and combine the filtrate and washings. Treat with ammonia, ammonium carbonate, and a little ammonium oxalate to precipitate calcium and barium. Allow to stand over night, filter, and wash thoroughly. Evaporate the filtrate and washings to dryness, dry in the oven, and finally drive off the ammonium salts by a gentle heat. Take up the residue with water, filter through a small filter, using as little wash water as possible, evaporate to a small volume, and finally again precipitate with a drop of ammonium hydroxid, and two or three drops of ammonium carbonate and oxalate. If any precipitate appears, which is not usually the case, filter and repeat the same process. In any case, filter the solution from the magnesium hydrate that is precipitated on concentrating the solution. Evaporate the filtrate to dryness and drive off all ammonium salts by heating in platinum to a little below redness. Take up the residue with a little water and run through a small filter, using as little wash water as possible, and again heat in platinum to a point slightly below red heat. By this time all of the magnesia should be removed. Take up the residue with a little water, filter into a weighed platinum dish, add a few drops of hydrochloric acid, and evaporate to dryness. Dry in an oven, heat to a little below redness, cool in a desiccator, and finally weigh the combined chlorids of potassium, sodium, and lithium.

The determination of lithium is then made according to the method of Gooch.^b

Dissolve the combined chlorids in water and transfer to a small beaker, and again evaporate practically to dryness. Add about 30 cc of dehydrated amyl alcohol (boiling point 130° C.) and boil till the temperature rises approximately to the boiling point of the amyl alcohol, showing that all of the water has been driven off. Cool slightly and add a drop of hydrochloric acid to reconvert small amounts of lithium hydrate to lithium chlorid. Continue the boiling to again drive off all water, until finally the liquid reaches a volume of about

^a The method given under "Waters for technical purposes," p. 12, may be used.

^b Amer. Chem. J., 1887, 9:23.

15 cc. Filter the amyl alcohol into a weighed platinum dish and wash the filter with a little amyl alcohol. Drive off the amyl alcohol from the filter and beaker in the air bath, and keep these for the determination of potassium and sodium. Evaporate the contents of the platinum dish to dryness, treat with a little sulphuric acid, and finally ignite and weigh. This gives the weight of the lithium sulphate, from which subtract 0.0017 gram to correct for the solubility of sodium and potassium chlorides in the amyl alcohol. Test the residue with the spectroscope for lithium. (If lithium is found with the spectroscope but is not present in sufficient quantity to weigh it is reported as a trace.)

Use the contents of the beaker and filter from which the amyl alcohol has been driven for the determination of potassium and sodium. Dissolve the contents of the beaker in hot water, filter, and thoroughly wash. Transfer the combined filtrate and washings to a porcelain dish. Add platinum chlorid solution and evaporate nearly to dryness. Treat the residue with 80 per cent alcohol, filter, and thoroughly wash with alcohol until the excess of platinum chlorid has been removed. Dry the filter paper, dissolve the residue in water, and transfer to a weighed platinum dish. Evaporate and dry the dish and contents at the temperature of boiling water, and weigh as potassium platonic chlorid. Calculate to potassium chlorid. An addition of 0.0008 gram of potassium chlorid is necessary to correct for its solubility in amyl alcohol.

The weight of the sodium chlorid is found by subtracting the combined weights of the lithium chlorid and the potassium chlorid (corrected) from the total weight of the three chlorids. If the amyl alcohol in the determination of lithium is not evaporated to exactly 15 cc the corrections will differ from those mentioned.^a

PHOSPHORIC ACID.

Treat another portion of the silica filtrate with about 10 cc of concentrated nitric acid and evaporate in a porcelain dish nearly to dryness to drive off hydrochloric acid. Take up the residue with water and, if necessary, filter. Add ammonium hydroxid to alkalinity and then just enough nitric acid to restore acidity. Add some ammonium nitrate and heat in the water bath from 45° to 50° C. Add molybdate solution and keep at a temperature of 45° to 50° C. for half an hour. The yellow precipitate formed at this point appears generally only in traces; if more than traces are present filter and wash with cold water until entirely free from nitric and molybdic acids. Transfer the precipitate and filter to a beaker, add a little water, and beat the paper and contents to a pulp. Dissolve the yellow precipitate by the addition of a small amount of standard potassium hydroxid solution (1 cc=1 mg of PO_4); add phenolphthalein and titrate with standard acid of exactly the same strength as the alkali solution. From the data so obtained calculate the phosphoric acid ions in the water to parts per million.^b

BARIUM AND STRONTIUM.^c

The washed residue^d remaining after evaporating a large quantity of the water with sodium carbonate and filtering is used for this determination. Dry the filter and contents and transfer the residue to a large platinum dish, burn the filter and add the ash to the platinum dish. Treat the residue thus obtained twice with sulphuric and hydrofluoric acids to remove silica, and drive off the excess of these substances each time by heating with the full flame of a Bunsen burner. Fuse the residue with sodium carbonate (care being taken that the entire residue is acted upon), treat with water and a few drops of alcohol to dissolve the excess of sodium carbonate and sodium sulphate formed, filter and carefully wash until all traces of sulphates disappear from the wash water. Digest the contents of the filter with hot dilute acetic acid to dissolve barium, strontium, magnesium, and calcium carbonates. It sometimes happens at this point that undissolved iron comes through the filter and can not be washed out. If so, add ammonium hydroxid to the filtrate to alkalinity; then heat to

^a For the discussion of this point see original article by Gooch, loc. cit.

^b U. S. Dept. Agr., Bureau of Chemistry Bul. 107, Revised, p. 4.

^c Gooch and Whitford, U. S. Geological Survey Bul. 47.

^d For an explanation of how this residue is obtained see method of preparing solution for determinations of barium, iodine, arsenic, and boric acid.

coagulate the iron, filter, and wash. Make the filtrate very slightly acid with acetic acid and add about 50 times the weight of the combined sulphates supposed to be present in ammonium sulphate which is dissolved in four times its weight of water. Heat on the steam bath until the sulphates of barium and strontium settle out and allow to stand over night.

Filter the precipitated sulphates and wash with a concentrated solution of ammonium sulphate until no more calcium is present in the wash water. Ignite the filter to a white ash, then treat with a few drops of sulphuric acid, ignite again, and weigh. The residue thus obtained consists of barium and strontium sulphates. Digest this residue for twenty-four hours (with frequent stirring) with ammonium carbonate solution to change the strontium sulphate to strontium carbonate. Transfer the residue remaining to a filter, wash, and dissolve the strontium carbonate with dilute hydrochloric acid. Wash the residue, ignite as before, and weigh the barium sulphate. The difference between the last weight and the total weight gives strontium sulphate. (To determine absolutely that the strontium has been dissolved out and not calcium, evaporate the small amount of hydrochloric acid extract to a small volume and test with the spectroscope. It occasionally happens that a very minute residue is weighable and yet consists of calcium only, which has not been completely washed out.)

BROMIN, IODIN, ARSENIC, AND BORON.

Evaporate large quantities of water to dryness, after the addition of small amounts of sodium carbonate. Boil the residue thus obtained with distilled water, transfer to a filter, and thoroughly wash with hot water. Make the alkaline filtrate up to a definite volume, and determine the constituents specified in aliquot portions.

IODIN AND BROMIN.

Qualitative method.

The qualitative tests for the presence of iodine and bromine are very much the same as those given by Fresenius. Evaporate an aliquot portion of the alkaline filtrate to dryness on the steam bath. Add 2 or 3 cc of water to dissolve the residue and enough absolute alcohol to make the percentage of alcohol about 90. Boil and filter, and repeat the treatment of the residue with 90 per cent alcohol once or twice. Add 2 or 3 drops of sodium hydrate solution to the filtrate and evaporate to dryness. Repeat the process of extracting with 90 per cent alcohol on the new residue, and filter the extract from the undissolved portion. Add a drop of sodium hydroxid to the filtrate and evaporate to dryness. Treat the residue with a little distilled water, add dilute sulphuric acid to acid reaction, transfer the liquid to a test-tube, add a little carbon bisulphid, and 3 or 4 drops of 2 per cent potassium nitrite solution, and vigorously shake the test-tube. The presence of iodine is shown by a pink color in the carbon bisulphid. Add chlorine water until the pink color due to the iodine has disappeared and then a little more chlorine water. The presence of bromine is shown by an orange color in the carbon bisulphid.

In most cases the above qualitative examination is sufficient, since iodine and bromine are usually not present, or only as traces. If qualitative examination shows a large amount of bromine, the following method, devised by Gooch and Whitfield,^a is used:

Gravimetric method.

Evaporate an aliquot portion of the alkaline filtrate to dryness and extract with 90 per cent alcohol, as in the qualitative examination just described. Evaporate the alcoholic extract to dryness, acidulate with dilute sulphuric acid, mix with a ferric sulphate solution, and distil from a retort which is joined to a condenser, sealed by a U-tube filled with water and carbon bisulphid. If iodine is present, it colors the carbon bisulphid and is titrated with standard sodium thiosulphate.

After the distillation has been continued long enough to be sure that all iodine has been volatilized, add crystals of potassium permanganate and continue the distillation as before, except that the U-tube, acting as a seal, is now filled with water and chloroform. Treat the contents of the tube with sodium hydroxid

^a U. S. Geological Survey Bul. 47.

and zinc in a beaker and acidify the chlorid and bromid solution so formed with nitric acid and precipitate with silver nitrate. Dry the precipitate and weigh. Dissolve in potassium cyanid and precipitate the silver by electrolysis.^a From the combined weight of the silver chlorid and bromid and the determined silver the necessary data are obtained for the calculation of the bromin.

Colorimetric method.^{b c}

Evaporate an aliquot portion of the alkaline filtrate (p. 9) to dryness and extract with 90 per cent alcohol as in the qualitative examination just described. Dissolve the residue in a little water, acidify with sulphuric acid (1 to 5), using 3 or 4 drops in excess, and transfer to a small flask. Add 4 drops of 2 per cent potassium nitrite solution and about 5 cc of carbon bisulphid freshly purified by distillation. Shake until all iodine is extracted. Filter off the acid solution from the carbon bisulphid. Wash the flask, filter, and contents with cold distilled water and transfer the carbon bisulphid (containing the iodine in solution) to a 12 cc Nessler^d tube by means of about 5 cc of pure carbon bisulphid. Make the contents of the tube up to the mark and match the color with that of other 12 cc tubes containing known amounts of iodine dissolved in carbon bisulphid. Prepare the standard tubes by taking measured quantities of a solution of known potassium iodide content, acidifying with sulphuric acid (1 to 5), adding 3 or 4 drops of potassium nitrite, and extracting with carbon bisulphid just as in the actual determination.

Use the filtrate from the carbon bisulphid for determining bromine. Add to the filtrates from the iodine standards, different measured quantities of a potassium bromide solution of known strength, the standards being run with the actual determination, and conducted in exactly the same way. Transfer the filtrates, both from the actual determination and from the standards, to small flasks and add freshly prepared chlorin water. Usually from 2 to 8 cc of a saturated solution of chlorin is sufficient. Care must be taken not to add too much chlorin in excess of that necessary to set the bromine free, since a bromochloride may be formed with an excess of the reagent, thus spoiling the color reaction.

The best results are obtained by adding approximately the same excess of chlorin to the standards as to the actual determination. This may be accomplished by adding the chlorin water 1 cc at a time and shaking between additions. After a little practice one can approximately determine when the chlorin ceases to set bromine free. After all bromine has been thus set free add 5 cc of freshly purified carbon bisulphid to each of the flasks and shake thoroughly. Filter off the water solution from the carbon bisulphid through a moistened filter, wash the contents of the filter two or three times with water, and then transfer to a 12 cc Nessler tube by means of about 1 cc of carbon bisulphid. Repeat this extraction of the filtrate twice, using 3 cc of carbon bisulphid each time. The combined carbon bisulphid extracts usually amount to from 11.5 to 12 cc. If they do not quite reach the 12 cc mark, add enough carbon bisulphid to each tube to bring them to the required volume and compare the sample with the standards. In some cases when working with the method near its upper limit the bromine is not all extracted by the amounts of carbon bisulphid recommended. If so, make one or two extra extractions with carbon bisulphid, transfer the extracts to another 12 cc tube, and compare the color with some of the lower standards.

^a Whitfield, Amer. Chem. J., 1886, 8: 421.

^b After the referee had used the qualitative method on a number of waters the need of a shorter method became apparent, both on account of the time element involved and because of the fact that in evaporating large volumes of heavily mineralized waters the large quantities of salts other than iodides and bromides are very difficult to handle. A colorimetric method was therefore devised (based on the usual qualitative method of examination) for use when bromides and iodides are present in moderately small quantities. When these constituents are present in very large quantities, however, the Gooch and Whitfield method should be followed.

^c U. S. Dept. Agr., Bureau of Chemistry Bul. 91, Mineral Waters of the United States.

^d This tube was made from the ordinary 10 cc Nessler tube by re-marking it at the 12 cc level.

ARSENIC.

Evaporate an aliquot portion of the alkaline filtrate, previously described, to dryness. Acidify with arsenic-free sulphuric acid and subject to the action of arsenic-free zinc and sulphuric acid in a Marsh-Berzelius apparatus. Compare the mirror obtained with a mirror prepared from an arsenious oxid solution of known strength.^a

BORIC ACID.

Evaporate a part of the alkaline filtrate, previously described, to dryness, treated with 1 or 2 cc of water, and slightly acidify with hydrochloric acid. Add about 25 cc of absolute alcohol, boil, filter, and repeat the extraction of the residue. Make the filtrate slightly alkaline with sodium hydroxid and evaporate to dryness. Add a little water, slightly acidify with hydrochloric acid, and place a strip of turmeric paper in the liquid. Evaporate to dryness on the steam bath and continue the heating until the turmeric paper is dry. In case boric acid is present the turmeric paper takes on a cherry-red color. It is not usually necessary to determine boric acid quantitatively. For the sake of completeness, a reference is given to a most excellent quantitative method devised by Gooch.^b

CARBONIC (CO_2) AND BICARBONIC (HCO_3) ACIDS.

To 100 grams of the water add a few drops of phenolphthalein and if a pink color is produced titrate with twentieth-normal acid potassium sulphate, adding a drop every two or three seconds, until the red color has disappeared. Multiply by the factor 0.003, which gives the value of carbonic acid in grams. To the colorless solution from this titration, or to the original solution if no color is produced with phenolphthalein, add one or two drops of methyl orange and continue the titration with the acid potassium sulphate without refilling the burette and note the total reading. If carbonic acid is absent, multiply the total burette reading by the factor 0.00305, which gives the value of bicarbonic acid in grams. If carbonic acid is present, multiply the reading with phenolphthalein by 2 and subtract from the total reading of the burette. Multiply the difference by the factor 0.00305, which gives the bicarbonic acid in grams. Multiply the result by 10 to reduce to grams per liter.

FREE CARBON DIOXID.

To 100 cc of the sample in a 200 cc flask add saturated solutions of the following reagents: 3 cc of calcium chlorid, 2 cc of ammonium chlorid, and 45 cc of calcium hydroxid, the strength of which has been determined immediately before using by means of tenth-normal hydrochloric acid, employing lacmoid as indicator. Cork the flask, shake thoroughly, and set aside until the precipitate has subsided, generally about twelve hours. Withdraw 50 cc of the clear solution and titrate with tenth-normal hydrochloric acid, using lacmoid. Multiply the number of cubic centimeters of acid used by 3 and subtract the result from the number of cubic centimeters equivalent to the 45 cc of standard lime water; the difference is the lime water used up, in precipitating the free carbon dioxid and the half-bound bicarbonic acid in terms of tenth-normal acid; multiply the results by the factor 0.0022, which gives the weight of carbon dioxid existing in the free state and as half-bound bicarbonic acid (total carbon dioxid in excess of that necessary to form normal carbonates), and multiply by 10 to reduce to grams per liter.

To obtain the free carbon dioxid subtract that given off from the bicarbonates when the water is evaporated to dryness (found by multiplying the bicarbonic acid obtained in the previous determination by the factor 0.3606) from the total carbon dioxid in excess of that necessary to form normal carbonates. The weight of carbon dioxid thus found, in milligrams, is multiplied by the factor 0.508 to reduce the result to cubic centimeters at 0° and 760 mm pressure.

^a See Haywood and Warner, Bureau of Chemistry Bul. 86, for further details.

^b Amer. Chem. J., 1887, 9: 23.

METHOD OF REPORTING RESULTS.

In reporting the results of analysis give the bases and acids in parts per million of the positive and negative ions, except in the case of silica, which report as such without considering how much is present as the silicic acid ion and how much as free silica. Report iron and aluminum when present in unimportant quantities together, and in calculations involving this figure consider it as iron. When iron and aluminum are present in larger quantities make the separation and report each separately.

In calculating the hypothetical combinations of acid and basic ions join sodium to nitrous and nitric acid, potassium to iodine and bromine, calcium to phosphoric acid, and sodium to metaboric acid. Assign the residual basic ions in the following order—ammonium, lithium, potassium, sodium, magnesium, calcium, manganese, iron, and aluminum—to the residual acid ions in the following order—chlorine, sulphuric acid ion, carbonic acid ion, and bicarbonic acid ion. In case the bicarbonic acid ion is not present in a sufficient quantity to join with all the calcium the residual calcium is joined to silica to form calcium silicate, and manganese, iron, and aluminum are calculated to the oxides Mn_2O_3 , Fe_2O_3 , and Al_2O_3 , respectively.

Waters for Technical Purposes.

TOTAL SALTS IN SOLUTION.

See method under mineral waters, page 6.

CHLORINE.

See method under sanitary waters, page 6.

COMBINED CARBONIC AND BICARBONIC ACIDS.

See method under mineral waters, page 11.

NITRATES.

See method under sanitary waters, page 4.

SILICA.

See method under mineral waters, page 6. Generally one evaporation with hydrochloric acid for removal of silica is sufficient.

IRON AND ALUMINUM.

See method under mineral waters, page 6.

CALCIUM.

If no phosphoric acid is present concentrate the filtrate from the determination of iron and precipitate with ammonium hydroxid and oxalate as given under mineral waters, page 7.

MAGNESIUM.

Acidify the filtrate from the calcium determination with hydrochloric acid and concentrate to about 100 cc. Add an excess of sodium or ammonium phosphate, and make alkaline with ammonium hydroxid added, a drop at a time, with constant stirring. Allow to stand forty-eight hours and filter, wash two or three times by decantation with ammonium hydroxid (2.5 per cent), redissolve in hydrochloric acid, add a few cubic centimeters of phosphate solution, and reprecipitate by adding ammonium hydroxid as before. Allow to stand twelve hours, filter, wash with 2.5 per cent of ammonium hydroxid until free from chlorides, dry, ignite with blast, and weigh. This method of double precipitation is generally preferable to driving off the ammonium salts as described in the case of mineral waters, but for very exact work the latter method may be followed.

SULPHURIC ACID AND ALKALIS.

Follow the methods described under mineral waters, page 7. Generally, however, for technical purposes it is sufficiently accurate to determine the acids and the bases, except soda and potash, and then to calculate the excess of acid over base ions to the sodium salt, and state the alkali thus found as soda and potash by difference.

Irrigating Waters.

Determine total salts in solution, chlorin, carbonic and bicarbonic acids, sulphuric acid, calcium, and magnesium, by methods given under analysis of water for technical purposes, page 12. To make the hypothetical combination, calculate calcium and magnesium to the acid ions in the following order: bicarbonic, sulphuric, and chlorin, then calculate the remaining acid ions, including carbonic, to the corresponding salts of sodium.

Also determine black alkali by the following method:

BLACK ALKALI.^a*Solutions required.*

(1) A standard fiftieth-normal sodium carbonate solution (1 cc = 0.00106) sodium carbonate.

(2) A standard fiftieth-normal sulphuric acid solution (1 cc = 0.0010 calcium carbonate or 0.00136 calcium sulphate).

(3) Indicator, erythrosin (0.25 gram to a liter of water).

(4) Chloroform.

Determination.

Transfer 200 cc of the water to a platinum or silver dish, add from 50 to 100 cc of standard sodium carbonate (the quantity varies with the amount of soluble salts of calcium and magnesium present, the smaller amount usually being sufficient), and evaporate the mixture to dryness. Rub up the residue with distilled water, free from carbon dioxid,^b transfer to a 100 cc graduated flask, make up to the mark, thoroughly shake, stopper, and allow to stand until clear, which usually requires from twelve to fifteen hours. When clear remove, without disturbing the residue in the bottom of the flask, 50 cc equivalent to one-half of the original quantity of water and sodium carbonate added, and transfer to the titrating bottle. For this purpose use a bottle of the best white glass without any tinge of pink, with ground-glass stopper and of about 250 cc capacity. Add 5 cc of chloroform and 1 cc of erythrosin solution and titrate with the standard acid until the color disappears. The solution should be vigorously shaken after each addition of the acid, the chloroform producing a milky appearance which makes the reading of the end point sharp and certain.

If less sulphuric acid is required than that necessary to balance one-half of the sodium carbonate added, it is evident that some of the sodium carbonate has been used up (i. e., changed by reacting with soluble salts of calcium and magnesium), which is evidence that the solution originally contained no black alkali in excess but rather an excess of the so-called "permanent hardness." It is customary to express the hardness in terms of calcium carbonate or calcium sulphate. For irrigation purposes the latter is to be preferred. Therefore the difference in cubic centimeters between the sulphuric acid required and one-half of the sodium carbonate added is multiplied by the factor 0.00136, which gives the equivalent of calcium sulphate in 100 cc of the water. But if, on the other hand, more sulphuric acid is required than that equivalent to one-half of the sodium carbonate added, then black alkali was originally

^a Skinner, J. Amer. Chem. Soc., 1906, 28: 78.

^b For this purpose distilled water should be vigorously boiled until approximately one-third of the original volume is evaporated, then cooled and stoppered. An ordinary laboratory wash bottle should not be used to transfer the residue, as the carbon dioxid from the breath of the operator is sufficient to vitiate the results.

present in the solution and the difference in cubic centimeters is multiplied by the factor 0.00106, which gives the black alkali in terms of sodium carbonate in 100 cc of water.

COMMITTEE B.—F. W. WOLL, Chairman.

(Dairy products, foods and feeding stuffs, sugar, tannin, and medicinal plants and drugs.)

DAIRY PRODUCTS.

It is recommended—

(1) That the methods of analysis of condensed milk presented to the association at its last meeting and referred to the referee for 1909 be adopted as official. These methods are given in the Proceedings of the association for 1908, Bulletin 122, page 158, and Circular 43, page 8, of the Bureau of Chemistry, and are for—1. Preparation of samples, 2. Total solids, 3. Ash, and 4. Lactose.

Adopted.

(2) That the method for inverting sucrose in the sweetened product with citric acid, using 3 per cent of acid and boiling for forty minutes, be again tested.

Adopted.

(3) That methods for determining fat in both sweetened and unsweetened milk be studied, giving special attention to the modifications of the Babcock and extraction methods recently brought out in Bulletin 134 of the Indiana (Purdue University) Agricultural Experiment Station.

Adopted.

(4) That the standard for Babcock glassware, proposed by E. B. Holland and referred by vote of the association to the referee for 1909, be adopted as the official standard.

(This standard is printed on page 189 of the Proceedings of the Twenty-fifth Annual Convention of the Association, Bulletin 122; also on page 9 of Circular 43 of the Bureau of Chemistry.)

Adopted.

FOODS AND FEEDING STUFFS.

It is recommended—

(1) That the referee continue the study of the determination of acidity in cattle feeds.

Adopted.

MEDICINAL PLANTS AND DRUGS.

It is recommended—

(1) That the provisional methods for the determination of alkaloids designated as “(a) Total Extraction Method” and “(b) Aliquot Method” (Bulletin 107, Revised, p. 258), with the modifications introduced in 1908 (Bulletin 122, p. 130), be replaced by the following modifications:

Total extraction method.

Into a 200 to 250 cc flask weigh 10 grams of the powdered drug, add about 75 cc of ether-chloroform mixture (5 to 1 by volume), cork, and shake often

for several minutes. Add 5 cc of 10 per cent ammonia water, insert the stopper again securely and agitate continuously for two hours. Transfer as much of the mixture as possible to a small cylindrical percolator (25 mm in diameter, 25 cm long), the neck of which is provided with a purified cotton plug, receiving the percolate in a beaker or flask; rinse the residue in the flask into the percolator with additional portions of the ether-chloroform mixture, and when the liquid has receded sufficiently to expose the surface of the drug, pack the latter moderately by pressing a plug of purified cotton down upon it with a thick glass rod, and continue the percolation with the same mixture until the percolate gives no precipitate (at most only an opalescence) when 2 cc are evaporated and the residue is treated with 2 cc tenth-normal hydrochloric acid, the mixture filtered and the filtrate tested with Mayer's solution.^a Evaporate or distill the percolate to about 10 cc at a temperature not exceeding 70° C. To the residue in the flask add 10 cc of 2 per cent sulphuric acid, rotate for one minute, and transfer the whole to a separator, rinsing the flask into the separator successively with 25 cc of ether, 10 cc of 2 per cent sulphuric acid, 25 cc of ether and 5 cc of water. Shake out, making sure that the reaction is acid, filter the acid solution through a 7 cm filter into another separator and repeat the operation with 15 cc portions of acid three or more times until 10 drops of the last portion of acid, after allowing the volatile solvent to evaporate therefrom, gives no precipitate upon addition of 2 drops of Mayer's solution. (Note the number (y) of portions of acid required.) Wash the acid solution with 10 cc of ether-chloroform mixture (1 to 3 by volume), repeating if necessary until no more color is acquired by the mixture. Shake the combined ether-chloroform washings with 10 cc of water and discard the former, adding the water to the acid solution. Make the acid solution alkaline with ammonia water and shake out successively with four or more portions of 20 cc each (noting the number (z) required) of ether-chloroform mixture (1 to 3) until the evaporation residue of 20 drops when treated with 1 cc of tenth-normal hydrochloric acid gives no precipitate with 2 drops of Mayer's solution.^b Collect the portions of ether-chloroform in a separator, wash with 5 cc of water, and transfer to a tared flask or beaker, rinsing the separator with a few cubic centimeters of ether-chloroform, and evaporate the solvent at a temperature not exceeding 70° C.

(a) *Gravimetric.* Add 3 cc of ether, evaporate, and dry to constant weight at a temperature not exceeding 70° C. Report weight of alkaloidal residue.

(b) *Volumetric.* Dissolve the residue in 5 cc of alcohol, add 15 cc of water and 1 to 15 drops of cochineal indicator solution, measure in from a burette a slight excess of fiftieth-normal sulphuric acid, mix intimately, making sure that all the alkaloid is dissolved, and titrate back with fiftieth-normal potassium hydroxid. By means of a blank titration with the same amounts of the same alcohol, water, indicator, and acid, determine the amount of acid consumed. Report net amount of fiftieth-normal acid required.

Aliquot method.

Into a 200 to 250 cc flask weigh 15 grams of the powdered drug, add 150 cc of ether-chloroform mixture (5 to 1 by volume), cork, and shake often for several minutes. Add 5 cc of 10 per cent ammonia water, insert the stopper

^a Rinse down the outside of the percolator tip with a jet of solvent mixture to remove any deposit of alkaloid. Note the amount (x) of percolate collected.

^b Rinse down the outside of the separator tip with a jet of solvent mixture to remove any deposit of alkaloid.

again securely, and agitate continuously for two hours. Add 15 cc of water, or just sufficient to agglomerate the drug, shake, let settle a few minutes, and then, if the solution is clear, decant 100 cc into a 100 cc volumetric flask. Transfer the solution to a separator, rinsing the flask with a few cubic centimeters of ether-chloroform, and shake out with 20 cc (or sufficient to render acid) of 2 per cent sulphuric acid, filtering the acid through a 7 cm filter into another separator, and proceeding thereafter as directed under the total extraction method beginning "and repeat the operation with 15 cc portions of acid."

If a practically clear aliquot portion of the solution can not be decanted, the following expedients are tentatively suggested for removing the turbidity with a minimum loss by evaporation. If employed, the fact should be reported.

(1) Decant the solution into a cylindrical percolator (25 mm diameter, 25 cm long), the neck of which is provided with a purified cotton plug and inserted in the mouth of the volumetric flask, loosely corking the upper orifice of the percolator to hinder evaporation while 100 cc are being collected in the flask.

(2) Transfer the solution from the digestion flask to the 100 cc flask by means of the filtering siphon of Callioss (*Apoth. Zeitung* 24: 159), which may be extemporized as follows: Bend a glass tube of about 2 mm bore at two points about 15 cm apart in supplementary acute and obtuse angles so as to form parallel limbs. The limb forming the obtuse angle is 2 cm longer than the other and is connected by a perforated cork with a small filtering tube plugged with purified cotton. The end of the siphon tube should be in loose contact with the cotton. The other limb passes adjustably through a doubly perforated cork fitting the mouth of the digesting flask. The second perforation in this cork is fitted with a short tube which may be bent at a right angle. To transfer the solution, fit the cork carrying the two tubes in the mouth of the digestion flask, adjusting the siphon at the proper height, and inserting the discharging end of the filtering tube in the neck of the measuring flask. On blowing gently into the right-angled tube the siphon will fill and begin to operate.

This recommendation was referred to the association for action in 1910.

(2) That the method for the separation of acetanilid, caffen, and sodium bicarbonate substantially as formulated for work during the past year be made provisional.

This recommendation was referred to the association for action in 1910.

(3) That the method for the separation of acetphenetidin, caffen, and sodium bicarbonate be subjected to additional study.

Adopted.

(4) That the work of the study of microscopical and macroscopical methods and of the microchemical study of drugs be continued along present lines.

Adopted.

SUGAR.

It is recommended—

(1) That work on clarifying agents be continued another year, paying some attention to the composition of the basic lead acetate.

Adopted.

(2) That moisture methods be studied further.

Adopted.

(3) That for dark-colored products whose refractive index is to be determined, the diluent should be a saturated sugar solution and never water. With the sugar solution the following formula is used:

$$X = \frac{(A+B)C-BD}{A}$$

in which X=per cent dry substance to be found.

A=weight of the material taken and mixed with B.

B=weight of the sugar solution.

C=the per cent dry substance of the above mixture obtained from the refractive index.

D=the per cent dry substance of the pure solution obtained from its refractive index.

This recommendation was referred to the referee to be brought before the association for action in 1910.

(4) That under the method for the determination of copper contained in the precipitate of cuprous oxid (pp. 51-53, Bulletin 107, Revised) "(6) Direct weighing of cuprous oxid," page 53, be limited by the following insertion: "This method should be used only in determinations of reducing sugars in pure solutions. In all other products the copper of the cuprous oxid should be determined by some such method as Low's (Bulletin 107, Revised, p. 241) since the cuprous oxid is very apt to be contaminated with organic matter, as well as other mineral ash."

Adopted.

(5) That Horne's dry lead subacetate be adopted provisionally as a clarifying agent in sugar analysis for the polarization of cane and sorghum products.

Adopted.

COMMITTEE C.—A. L. WINTON,^a CHAIRMAN.

(Food adulteration.)

WATER IN FOODS.

It is recommended—

(1st) That the referee on this subject for next year test the vacuum method (without heat) in connection with the official method to determine what class of substances give incorrect data by the present official method; that the applicability of the Lowenstein alcohol method to certain classes of food products be also studied.

Adopted.

(2) That the methods for moisture determination be further studied with a view to determining their effect on the determination of the fat in food products.

Adopted.

SEPARATION OF NITROGENOUS BODIES—MEAT PROTEIDS.

It is recommended—

(1) That the referee for next year on the separation of meat proteids pay special attention to the development of methods. Details of manipulation

^a In the absence of Mr. Winton the report was presented by J. P. Street, Connecticut.

should be carefully worked out, especially with regard to determinations of amido acids, creatinin, and creatin.

Adopted.

(2) That an associate referee be appointed to make a special study of the inorganic and organic phosphorus compounds in foods, paying especial attention to the development of methods.

Adopted.

FLAVORING EXTRACTS.

It is recommended—

(1) That the provisional method for the determination of citral in lemon extracts be adopted as an official method.

Approved and referred to the association for final action in 1910.

MEAT AND FISH.

It is recommended—

(1) That the referee give special attention to the apparent error in the method for the determination of sugar in meat and meat products noted by Lowenstein in the Journal of the American Chemical Society, September, 1908.

Adopted.

[The referee on meat and fish recommended that the following method for testing the age of meats be tried on various kinds of meat products. This recommendation was not received in time to be acted upon by the committee, but is here submitted for the information of the association:]

Weigh 25 grams of finely ground meat or fish into beakers of 100 cc to 150 cc capacity, add 50 cc of pepsin-hydrochloric acid solution (1 gram of pepsin and 1 cc of hydrochloric acid to 500 cc of water) and after stirring the contents of the beaker thoroughly until all the larger particles of meat are broken up, place in an incubator at 37.5° C. for one and one-half hours. After incubation transfer to an 850 cc Erlenmeyer flask with 300 cc of water, add 10 to 15 grams of light magnesium oxid. free from sulphur and arsenic, and distil through a vertical condenser into an approximately hundredth-normal iodine solution for one hour, so arranging the gas flame that 200 cc distills over during this time. Loss of iodine by volatilization is guarded against by cooling the receiving flask, sealing the joints with paraffin and attaching four U tubes, each containing 5 cc of hundredth-normal sodium thiosulphate solution. The contents of the receiving flask and U tubes are poured into an Erlenmeyer flask and the excess of iodine titrated with hundredth-normal sodium thiosulphate using starch as an indicator. A blank should be run at the same time using the same amount of water and magnesium oxid. It is also well to run a control on a sample of absolutely fresh meat.

[The results are reported as cubic centimeters of hundredth-normal iodine required for 25 grams of meat.]

DAIRY PRODUCTS (ADULTERATION OF).

It is recommended—

(1) That the modified Baier and Neumann method for sugar in cream and milk be brought before the association next year and considered for provisional adoption.

Adopted.

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(2) That a further study be made of the methods for determining calcium oxid and the alkalinity of ash in cream.

Adopted.

(3) That a study be made of the copper method of preparing milk serum.

Adopted.

ACTION TAKEN AFFECTING THE CONDUCT OF THE WORK.

The following motions based on recommendations made in the president's address were carried:

(1) That the president be authorized to appoint three delegates to the U. S. Pharmacopœial Convention.

(Pending the action of the convention defining the eligibility of delegates these appointments will not be announced.)

(2) That a copy or abstract of referee's reports should accompany the recommendations submitted three weeks before the annual meeting of the association.

Referees please note: That in accordance with the motion passed in 1908, these recommendations, forwarded to the chairman of the appropriate subcommittees, must also be approved by the committee as a whole, and to this end the chairmen of the subcommittees should be ready with their reports a few days before the meeting.)

(3) That a committee be appointed to compile in the form of by-laws, or otherwise, the regulations of the association for the conduct of its business.

(W. D. Bigelow, Washington, D. C., chairman; C. L. Penny, of Delaware, and R. N. Brackett, of South Carolina, have been appointed.)

The following motions were also made as to changes in the constitution:

(1) That section 1 of the constitution be amended by adding after the words "dairy products" in line 4, the words "human foods, medicinal plants, drugs."

(2) That section 2 of the constitution be amended to read as follows:

"Section 2. Analytical chemists connected with the United States Department of Agriculture, or with any state, provincial, or national agricultural experiment station or agricultural college, or with any state, provincial or national institution or body in North America charged with official control of the materials named in section 1, shall alone be eligible to membership, and one such representative for each of these institutions, or boards, when properly accredited, shall be entitled to enter motions or vote in the association. Only such chemists as are connected with institutions exercising official fertilizer control shall vote on questions involving methods of analyzing fertilizers, or involving definitions, nomenclature, laws, or regulations relating to fertilizers. Only such chemists as are connected with institutions exercising official cattle food control shall vote on questions involving methods of analyzing cattle foods or involving nomenclature, definitions, laws, or regulations relating to cattle food. Only such chemists as are connected with institutions exercising official food or drug control shall vote on questions involving methods of

analyzing food or drugs or involving nomenclature, definitions, laws, or regulations relating to food or drugs. All persons eligible to membership shall become members ex officio and shall be allowed the privileges of membership at any meeting of the association after presenting proper credentials. All members of the association who lost their right to such membership by retiring from positions indicated as requisite for membership shall be entitled to become honorary members and to have all privileges of membership, save the right to hold office and vote. All analytical chemists and others interested in the objects of the association may attend its meetings and take part in its discussions, but shall not be entitled to enter motions or vote."

It was voted that the motions to amend the constitution be referred to a committee of three, to be appointed by the president-elect, and be reported to the association at the next meeting. (Messrs. L. L. Van Slyke, William Frear, and B. B. Ross have been appointed by the president.)

Two important committee reports, especially called to the attention of the members as affecting the interests of the association and the conduct of the work, are given in full that appropriate action may be taken:

REPORT OF FINANCE COMMITTEE.

It is recommended—

(1) That each agricultural college, experiment station, and each other body whose chemist is entitled to vote in this association be requested to pay to the secretary the sum of \$2 for the purpose of meeting the expenses already incurred in printing and sending out notices of this meeting and other incidental expenses, up to and including the next meeting, which were met in previous years by the United States Department of Agriculture, but which under recent rulings can no longer be met by the Department, unless Congress makes an appropriation for this purpose.

Adopted.

(Members will please take note of this action and forward dues at once to the secretary.)

(2) That a committee of three be appointed by the president of the association to ask the approval of the Secretary of Agriculture of a request to Congress to appropriate the sum of \$500 annually to the United States Department of Agriculture for the purpose of meeting such expenses of this association as can not now be lawfully met by the Department.

Adopted.

E. M. MAGRUDER,
JOHN PHILLIPS STREET,
H. A. HUSTON.

(Messrs. J. P. Street, H. E. Barnard, and R. J. Davidson were appointed by President Withers on this committee.)

REPORT OF COMMITTEE ON ALCOHOL TABLES.

The committee appointed at the last meeting of the association, after considering the question of alcohol tables, has the following report to make:

The Bureau of Standards has ready at the present time a complete set of tables for the determination of alcohol, based on the latest and most official

data on the subject. The committee after consideration of these tables feels that it would be wise for the association to adopt them in place of those now printed in Bulletin 107, Revised.

The tables which we now have, are not based on the same specific gravity of pure alcohol, and we have no table from 50 per cent to 100 per cent that gives anything except full per cents. The new tables prepared by the Bureau of Standards are all based on the same specific gravity of pure alcohol, so that there is perfect agreement among them. These tables, which are submitted to the association for consideration, are five in number as follows:

No. 1. Density of all mixtures of ethyl alcohol and water at three different temperatures, $15^{\circ}/4^{\circ}$ C., $20^{\circ}/4^{\circ}$ C., and $25^{\circ}/4^{\circ}$ C., for each per cent by weight from 0 to 100.

No. 2. Densities of mixtures of ethyl alcohol and water at $20^{\circ}/4^{\circ}$ C. for each one-tenth per cent from 0 to 100.

No. 3. Specific gravity of mixtures of ethyl alcohol and water at 60° F. ($15.56^{\circ}/15.56^{\circ}$ C.) gives the per cent alcohol by volume for each one-tenth per cent from 0 to 100.

No. 4. To convert per cents by weight, of mixtures of ethyl alcohol and water, into per cents of alcohol by volume at 60° F. for each one-tenth per cent from 0 to 100.

No. 5. A table for converting per cents by volume to per cents by weight.

In this connection, it is reported that the committee had a meeting with the Commissioner of Internal Revenue, in which the question of these tables was taken up and discussed, and it was agreed that the Bureau of Internal Revenue would adopt the standard tables proposed by the Bureau of Standards; there has been prepared for the gauger's manual a table corresponding to Table III, at $60^{\circ}/60^{\circ}$ F., showing the degrees proof corresponding to the per cents by volume, but as yet final action has not been taken by the Commissioner of Internal Revenue regarding this matter.

The adoption by the association of these tables would still leave us in a rather unsatisfactory position, as in a large part of the inspection work carried on under the various state laws and the National law the use of the United States Pharmacopœia is required, and the tables recommended would not agree with those now given in that publication. It is therefore recommended that final action upon these tables be deferred a year, and that the committee be instructed to take up this matter with the revision committee of the Pharmacopœia and see if it is not possible to come to some definite agreement as to the temperature at which alcohol per cents should be given and also some agreement as to the tables to be used. It is also suggested that these tables be printed as part of the report of this committee, so that they can be considered by the association during the year and be ready for adoption, if so desired, at the next meeting of the association.

L. M. TOLMAN, *Chairman.*

M. E. JAFFA,

A. B. ADAMS,

R. J. DAVIDSON,

H. E. BARNARD,

Committee on Standardization of Alcohol Tables.

It was moved and carried that the report of the committee be accepted and printed and the committee continued. The tables to be considered by the association are appended.

ALCOHOL TABLES OF THE BUREAU OF STANDARDS PROPOSED FOR ADOPTION BY THE
ASSOCIATION IN 1910.

[The asterisk indicates a diminution of one in the second place decimal.]

TABLE I.—*Density of mixtures of ethyl alcohol and water.*

Per cent alcohol by weight.	D ₁₅ ^a	D ₂₀ ^a	D ₂₅ ^a	Per cent alcohol by weight.	D ₁₅ ^a	D ₂₀ ^a	D ₂₅ ^a
0	0.99913	0.99824	0.99708	50	0.91787	0.91386	0.90983
1	.99725	.99636	.99521	51	.91566	.91164	.90758
2	.99543	.99453	.99338	52	.91344	.90940	.90533
3	.99366	.99274	.99159	53	.91120	.90715	.90307
4	.99197	.99102	.98984	54	.90895	.90488	.90079
5	.99033	.98936	.98815	55	.90670	.90262	.89851
6	.98877	.98776	.98651	56	.90443	.90034	.89622
7	.98726	.98620	.98491	57	.90215	.89805	.89392
8	.98581	.98470	.98336	58	.89987	.89576	.89162
9	.98442	.98325	.98185	59	.89758	.89346	.88931
10	.98307	.98185	.98038	60	.89528	.89115	.88700
11	.98176	.98047	.97893	61	.89297	.88883	.88467
12	.98049	.97913	.97752	62	.89066	.88651	.88234
13	.97925	.97781	.97612	63	.88834	.88418	.88000
14	.97803	.97651	.97474	64	.88601	.88185	.87766
15	.97683	.97522	.97336	65	.88368	.87950	.87530
16	.97563	.97393	.97199	66	.88134	.87716	.87295
17	.97444	.97264	.97061	67	.87899	.87480	.87058
18	.97324	.97134	.96922	68	.87664	.87244	.86821
19	.97203	.97003	.96782	69	.87428	.87008	.86583
20	.97080	.96870	.96640	70	.87192	.86770	.86344
21	.96956	.96736	.96497	71	.86954	.86532	.86105
22	.96829	.96599	.96352	72	.86716	.86292	.85864
23	.96699	.96459	.96203	73	.86477	.86052	.85622
24	.96566	.96317	.96052	74	.86237	.85812	.85380
25	.96430	.96171	.95897	75	.85997	.85570	.85137
26	.96289	.96021	.95739	76	.85755	.85328	.84893
27	.96145	.95868	.95577	77	.85513	.85084	.84648
28	.95997	.95711	.95412	78	.85270	.84840	.84403
29	.95845	.95550	.95244	79	.85026	.84595	.84157
30	.95688	.95385	.95071	80	.84781	.84349	.83909
31	.95526	.95215	.94894	81	.84534	.84101	.83660
32	.95360	.95042	.94713	82	.84286	.83852	.83410
33	.95191	.94865	.94529	83	.84037	.83602	.83159
34	.95017	.94684	.94342	84	.83786	.83350	.82906
35	.94839	.94499	.94152	85	.83534	.83097	.82652
36	.94657	.94311	.93957	86	.83279	.82842	.82396
37	.94471	.94119	.93760	87	.83022	.82583	.82137
38	.94282	.93924	.93560	88	.82762	.82323	.81876
39	.94089	.93725	.93356	89	.82500	.82060	.81613
40	.93893	.93524	.93151	90	.82235	.81795	.81348
41	.93694	.93320	.92943	91	.81966	.81527	.81080
42	.93491	.93113	.92732	92	.81694	.81255	.80809
43	.93286	.92904	.92519	93	.81418	.80979	.80534
44	.93078	.92693	.92305	94	.81138	.80700	.80256
45	.92868	.92480	.92088	95	.80854	.80417	.79974
46	.92655	.92264	.91870	96	.80564	.80129	.79689
47	.92441	.92047	.91650	97	.80271	.79838	.79400
48	.92225	.91828	.91429	98	.79972	.79541	.79106
49	.92006	.91608	.91207	99	.79668	.79240	.78809
50	.91787	.91386	.90983	100	.79358	.78933	.78507

^a D₁₅^a=Density at 15° C. referred to water at 4° C.

TABLE II.—*Density of mixtures of ethyl alcohol and water at 20° $\frac{20^{\circ}}{4^{\circ}}$ C.*

Per cent alcohol by weight.	Tenths of per cent.									
	0	1	2	3	4	5	6	7	8	9
0	0.99824	804	786	767	748	729	710	692	673	654
1	.99636	617	599	580	562	544	525	507	489	471
2	.99453	434	417	399	381	363	345	327	310	292
3	.99274	257	240	222	205	188	171	154	136	119
4	.99102	086	069	052	035	019	002	*986	*969	*952
5	.98936	920	904	887	871	855	839	823	807	791
6	.98776	760	744	729	713	697	682	666	651	636
7	.98620	605	590	575	560	545	530	515	500	485
8	.98470	456	441	426	412	397	383	368	354	340
9	.98325	311	297	283	269	255	241	227	213	199
10	.98185	171	157	143	130	116	102	088	074	061
11	.98047	034	020	006	*993	*979	*966	*953	*939	*926
12	.97913	899	886	873	860	846	833	820	807	794
13	.97781	768	755	742	728	715	702	689	676	663
14	.97651	638	625	612	599	586	573	560	547	535
15	.97522	509	496	483	470	457	444	432	419	406
16	.97393	380	367	354	341	328	316	303	290	277
17	.97264	251	238	225	212	199	186	173	160	147
18	.97134	121	108	095	082	068	055	042	029	016
19	.97003	*989	*976	*963	*950	*936	*923	*910	*896	*883
20	.96870	856	843	830	816	803	790	776	763	749
21	.96736	722	708	695	681	668	654	640	626	613
22	.96599	585	571	557	544	530	516	502	488	473
23	.96459	445	431	417	403	388	374	360	346	331
24	.96317	302	288	273	259	244	230	215	200	186
25	.96171	156	141	126	111	096	081	066	051	036
26	.96021	006	*991	*975	*960	*945	*929	*914	*899	*883
27	.95868	852	837	821	806	790	774	759	743	727
28	.95711	695	679	663	647	631	615	599	583	566
29	.95550	534	518	501	485	468	452	435	419	402
30	.95385	369	352	335	318	301	284	267	250	232
31	.95215	198	181	164	146	129	112	094	077	059
32	.95042	024	007	*989	*971	*954	*936	*918	*900	*883
33	.94865	847	829	811	793	775	757	739	720	702
34	.94684	666	647	629	611	592	574	555	537	518
35	.94499	481	462	443	424	406	386	368	349	330
36	.94311	292	272	253	234	215	196	176	157	138
37	.94119	099	080	061	041	022	002	*983	*963	*944
38	.93924	904	884	864	845	825	805	785	765	745
39	.93725	705	685	665	645	625	605	585	565	545
40	.93524	504	484	464	443	423	402	382	362	341
41	.93320	300	279	259	238	217	196	176	155	134
42	.93113	092	072	051	030	009	*988	*967	*946	*925
43	.92904	883	862	841	820	799	778	757	736	714
44	.92693	672	651	629	608	587	566	544	523	501
45	.92480	458	437	415	394	372	351	329	308	286
46	.92264	243	221	199	178	156	134	112	091	069
47	.92047	025	004	*982	*960	*938	*916	*894	*872	*850
48	.91828	806	784	762	740	718	696	674	652	630
49	.91608	586	564	542	519	497	475	453	431	408
50	.91386	364	342	319	297	275	253	230	208	186

TABLE II.—*Density of mixtures of ethyl alcohol and water at 20°
 4° C.*—Continued.

Per cent alcohol by weight.	Tenths of per cent.									
	0	1	2	3	5	6	7	8	8	9
51	0.91164	141	119	096	074	052	029	007	*984	*962
52	.90940	917	895	872	850	827	805	782	760	737
53	.90715	692	670	647	624	602	579	556	534	511
54	.90488	466	443	420	398	375	352	330	307	284
55	.90262	239	216	193	170	148	125	102	079	056
56	.90034	011	*988	*965	*942	*919	*896	*874	*851	*828
57	.89805	782	759	736	713	690	668	645	622	599
58	.89576	553	530	507	484	461	438	415	392	369
59	.89346	323	300	277	254	230	207	184	161	138
60	.89115	092	069	046	022	*999	*976	*953	*930	*906
61	.88883	860	837	814	791	767	744	721	698	674
62	.88651	628	605	581	558	535	512	488	465	442
63	.88418	395	372	348	325	302	278	255	231	208
64	.88185	161	138	114	091	068	044	021	*997	*974
65	.87950	927	904	880	857	833	810	786	763	739
66	.87716	692	669	645	622	598	574	551	527	504
67	.87480	457	433	409	386	362	339	315	291	268
68	.87244	221	197	173	150	126	102	079	055	031
69	.87008	*984	*960	*936	*913	*889	*865	*842	*818	*794
70	.86770	746	722	699	675	651	627	603	580	556
71	.86532	508	484	460	436	412	388	364	340	316
72	.86292	268	245	221	197	173	149	125	101	076
73	.86052	028	004	*980	*956	*932	*908	*884	*860	*836
74	.85812	788	764	739	715	691	667	643	618	594
75	.85570	546	522	497	473	449	425	400	376	352
76	.85328	303	279	255	230	206	182	157	133	109
77	.85084	060	036	011	*987	*962	*938	*914	*889	*865
78	.84840	816	791	767	742	718	693	669	644	620
79	.84595	571	546	521	497	472	448	423	398	374
80	.84349	324	299	275	250	225	200	176	151	126
81	.84101	076	051	026	002	*977	*952	*927	*902	*877
82	.83852	827	802	777	752	727	702	677	652	627
83	.83602	577	552	526	501	476	451	426	401	376
84	.83350	325	300	274	249	224	198	173	147	122
85	.83097	071	046	020	*995	*969	*944	*918	*893	*867
86	.82842	816	790	764	738	713	687	661	635	609
87	.82583	557	531	506	479	453	427	401	375	349
88	.82323	297	270	244	218	192	165	139	113	086
89	.82060	034	007	*981	*954	*928	*901	*875	*848	*822
90	.81795	768	742	715	688	661	634	608	581	554
91	.81527	500	473	446	418	391	364	337	310	282
92	.81255	228	200	173	145	118	090	062	035	007
93	.80979	952	924	896	868	840	812	784	756	728
94	.80700	672	644	616	587	559	531	502	474	445
95	.80417	388	360	331	302	274	245	216	187	158
96	.80129	100	071	042	013	*984	*955	*926	*896	*867
97	.79838	808	779	749	720	690	660	631	601	571
98	.79541	511	481	451	421	391	361	331	300	270
99	.79240	209	179	148	118	087	056	026	*995	*964
100	.78933									

[Cir. 52]

TABLE III.—*Specific gravity of mixtures of ethyl alcohol and water at $\frac{60^\circ}{60^\circ}$ F. ($\frac{15.56^\circ}{15.56^\circ}$ C.)*

Per cent alcohol by vol- ume at F.	Tenths of per cent.									
	0	1	2	3	4	5	6	7	8	9
0	1.00000	*985	*970	*954	*940	*924	*910	*894	*880	*865
1	.99850	835	820	805	791	776	761	747	732	718
2	.99703	688	674	660	645	631	616	602	588	574
3	.99560	545	531	517	503	489	475	461	447	433
4	.99419	405	392	378	364	350	337	323	310	296
5	.99283	269	256	243	230	216	203	190	177	164
6	.99150	137	124	111	098	086	073	060	047	034
7	.99022	009	*996	*984	*971	*959	*946	*934	*922	*909
8	.98897	885	872	860	848	836	824	812	800	788
9	.98776	764	752	740	728	716	705	693	681	670
10	.98658	646	635	623	612	600	589	578	566	555
11	.98544	532	521	510	499	488	477	466	454	444
12	.98432	422	410	400	389	378	367	356	345	334
13	.98324	313	302	291	281	270	259	249	238	227
14	.98217	206	196	185	175	164	154	144	133	123
15	.98112	102	092	082	071	061	051	040	030	020
16	.98010	000	*989	*979	*969	*959	*949	*939	*928	*918
17	.97908	898	888	878	868	858	848	838	828	818
18	.97808	798	788	778	768	758	748	738	728	718
19	.97708	698	688	678	668	658	648	637	627	617
20	.97607	597	587	577	567	557	547	537	527	517
21	.97507	497	487	477	466	456	446	436	426	416
22	.97406	396	386	375	365	355	345	334	324	314
23	.97304	294	283	273	263	252	242	232	221	211
24	.97200	190	180	169	159	148	138	127	117	106
25	.97096	085	074	064	053	043	032	022	011	000
26	.96990	979	968	957	946	936	925	914	903	892
27	.96881	870	859	848	837	826	815	804	792	781
28	.96770	759	748	736	725	714	702	691	679	668
29	.96656	645	633	622	610	599	587	575	564	552
30	.96540	528	516	504	492	481	469	456	444	432
31	.96420	408	396	384	372	359	347	335	322	310
32	.96297	285	272	260	248	235	222	210	197	184
33	.96172	159	146	133	120	107	094	082	068	055
34	.96042	029	016	003	*990	*976	*963	*950	*936	*923
35	.95909	896	882	868	855	841	827	814	800	786
36	.95772	758	744	730	716	702	688	673	659	645
37	.95630	616	602	587	573	558	544	529	515	500
38	.95485	471	456	441	426	412	397	382	367	352
39	.95337	322	306	291	276	261	246	230	215	200
40	.95184	168	153	137	122	106	090	075	059	043
41	.95027	011	*995	*979	*963	*947	*931	*915	*899	*883
42	.94866	850	834	817	801	784	768	751	735	718
43	.94702	685	668	651	634	618	601	584	567	550
44	.94532	515	498	481	464	447	429	412	395	377
45	.94360	342	325	307	290	272	254	236	219	201
46	.94183	165	147	129	111	093	076	058	039	021
47	.94003	*985	*967	*948	*930	*912	*893	*875	*856	*838
48	.93819	801	782	764	745	726	707	688	670	651
49	.93632	613	594	575	556	536	517	498	479	460
50	.93440	421	402	382	363	343	324	304	285	265

[Cir. 52]

TABLE III.—*Specific gravity of mixtures of ethyl alcohol and water at 60° F. $\left(\frac{15.56^{\circ}}{15.56^{\circ}}\right)$ C.*

Per cent alcohol by vol- ume at 60° F.	Tenths of per cent.									
	0	1	2	3	4	5	6	7	8	9
51	.93246	226	206	187	167	147	128	108	088	068
52	.93048	028	008	* 988	* 968	* 948	* 928	* 908	* 887	* 867
53	.92847	827	806	786	766	745	725	704	684	663
54	.92643	622	601	581	560	539	518	498	477	456
55	.92435	414	393	372	351	330	309	288	267	246
56	.92224	203	182	161	139	118	097	075	054	032
57	.92011	* 990	* 968	* 946	* 925	* 903	* 882	* 860	* 838	* 817
58	.91795	773	752	730	708	686	664	643	621	599
59	.91577	555	533	511	489	467	444	422	400	378
60	.91356	333	311	289	266	244	222	199	177	154
61	.91132	109	087	064	041	019	* 996	* 973	* 951	* 928
62	.90905	882	860	837	814	791	768	745	722	699
63	.90676	653	630	607	584	560	537	514	491	468
64	.90444	421	398	374	351	328	304	281	257	234
65	.90210	187	163	140	116	092	069	045	022	* 998
66	.89974	950	927	903	879	855	831	807	783	759
67	.89735	711	687	663	639	615	591	567	542	518
68	.89494	470	445	421	397	372	348	324	299	275
69	.89250	226	201	177	152	127	103	078	053	029
70	.89004	* 979	* 954	* 930	* 905	* 880	* 855	* 830	* 805	* 780
71	.88755	730	705	680	655	630	605	580	554	529
72	.88504	478	453	428	403	377	352	326	301	276
73	.88250	224	199	173	147	122	096	070	044	018
74	.87993	967	941	915	889	864	838	812	786	760
75	.87734	708	682	655	629	603	577	550	524	498
76	.87471	445	419	392	366	339	313	286	259	233
77	.87206	179	153	126	099	072	045	018	* 991	* 964
78	.86937	910	883	856	829	802	774	747	720	692
79	.86665	638	610	583	555	528	500	472	445	417
80	.86389	362	334	306	278	250	222	194	166	138
81	.86110	082	054	025	* 997	* 969	* 941	* 912	* 884	* 855
82	.85827	799	770	742	713	684	656	627	598	570
83	.85541	512	483	454	425	396	367	338	308	279
84	.85250	220	191	162	132	103	073	044	014	* 984
85	.84955	925	895	865	835	805	775	745	714	684
86	.84654	624	593	563	532	502	471	440	410	379
87	.84348	317	286	255	224	193	162	131	100	068
88	.84037	005	* 974	* 942	* 910	* 879	* 847	* 815	* 783	* 751
89	.83719	687	654	622	590	557	525	492	459	427
90	.83394	361	328	294	261	228	194	160	127	093
91	.83059	025	* 991	* 957	* 923	* 888	* 854	* 819	* 785	* 750
92	.82715	680	645	610	574	539	503	468	432	396
93	.82360	324	288	252	215	178	142	105	068	031
94	.81994	956	918	881	843	804	766	728	689	650
95	.81611	572	533	494	454	414	374	334	293	253
96	.81212	171	130	089	047	006	* 964	* 921	* 879	* 836
97	.80794	751	708	664	620	576	532	488	443	398
98	.80353	308	262	216	169	123	076	028	* 981	* 933
99	.79855	837	788	739	690	640	590	540	489	438
100	.79387									

TABLE IV.—*Per cents of alcohol by volume at 60° F., corresponding to various per cents by weight in mixtures of ethyl alcohol and water.*

Per cent alcohol by weight.	Tenths of per cent.									
	0	1	2	3	4	5	6	7	8	9
0	0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.01	1.13
1	1.26	1.38	1.51	1.63	1.76	1.88	2.01	2.13	2.26	2.38
2	2.51	2.63	2.76	2.88	3.01	3.13	3.26	3.38	3.51	3.63
3	3.76	3.88	4.01	4.13	4.26	4.38	4.50	4.63	4.75	4.88
4	5.00	5.13	5.25	5.37	5.50	5.62	5.75	5.87	5.99	6.12
5	6.24	6.37	6.49	6.61	6.74	6.86	6.98	7.11	7.23	7.36
6	7.48	7.60	7.73	7.85	7.97	8.10	8.22	8.34	8.47	8.59
7	8.71	8.84	8.96	9.08	9.20	9.33	9.45	9.57	9.70	9.82
8	9.94	10.07	10.19	10.31	10.43	10.56	10.68	10.80	10.92	11.05
9	11.17	11.29	11.41	11.54	11.66	11.78	11.90	12.03	12.15	12.27
10	12.39	12.52	12.64	12.76	12.88	13.00	13.13	13.25	13.37	13.49
11	13.62	13.74	13.86	13.98	14.10	14.22	14.35	14.47	14.59	14.71
12	14.83	14.95	15.08	15.20	15.32	15.44	15.56	15.68	15.81	15.93
13	16.05	16.17	16.29	16.41	16.53	16.66	16.78	16.90	17.02	17.14
14	17.26	17.38	17.50	17.62	17.75	17.87	17.99	18.11	18.23	18.35
15	18.47	18.59	18.71	18.83	18.95	19.08	19.20	19.32	19.44	19.56
16	19.68	19.80	19.92	20.04	20.16	20.28	20.40	20.52	20.64	20.76
17	20.88	21.00	21.12	21.24	21.36	21.48	21.60	21.72	21.84	21.96
18	22.08	22.20	22.32	22.44	22.56	22.68	22.80	22.92	23.04	23.16
19	23.28	23.40	23.52	23.64	23.76	23.88	24.00	24.12	24.24	24.36
20	24.48	24.59	24.71	24.83	24.95	25.07	25.19	25.31	25.43	25.55
21	25.67	25.78	25.90	26.02	26.14	26.26	26.38	26.50	26.62	26.73
22	26.85	26.97	27.09	27.21	27.33	27.44	27.56	27.68	27.80	27.92
23	28.04	28.15	28.27	28.39	28.51	28.62	28.74	28.86	28.98	29.10
24	29.21	29.33	29.45	29.57	29.68	29.80	29.92	30.03	30.15	30.27
25	30.39	30.50	30.62	30.74	30.85	30.97	31.09	31.21	31.32	31.44
26	31.56	31.67	31.79	31.91	32.02	32.14	32.26	32.37	32.49	32.60
27	32.72	32.84	32.95	33.07	33.18	33.30	33.42	33.53	33.65	33.76
28	33.88	34.00	34.11	34.23	34.34	34.46	34.57	34.69	34.80	34.92
29	35.03	35.15	35.26	35.38	35.49	35.61	35.72	35.84	35.95	36.07
30	36.18	36.30	36.41	36.52	36.64	36.75	36.87	36.98	37.10	37.21
31	37.32	37.44	37.55	37.67	37.78	37.89	38.01	38.12	38.23	38.35
32	38.46	38.58	38.69	38.80	38.91	39.03	39.14	39.25	39.37	39.48
33	39.59	39.71	39.82	39.93	40.04	40.16	40.27	40.38	40.49	40.61
34	40.72	40.83	40.94	41.05	41.17	41.28	41.39	41.50	41.61	41.72
35	41.84	41.95	42.06	42.17	42.28	42.39	42.50	42.62	42.73	42.84
36	42.95	43.06	43.17	43.28	43.39	43.50	43.61	43.72	43.83	43.94
37	44.06	44.16	44.27	44.38	44.49	44.60	44.71	44.82	44.93	45.04
38	45.15	45.26	45.37	45.48	45.59	45.70	45.81	45.92	46.03	46.14
39	46.25	46.36	46.46	46.57	46.68	46.79	46.90	47.01	47.12	47.23
40	47.33	47.44	47.55	47.66	47.77	47.87	47.98	48.09	48.20	48.31
41	48.41	48.52	48.63	48.74	48.84	48.95	49.06	49.17	49.27	49.38
42	49.49	49.59	49.70	49.81	49.91	50.02	50.13	50.23	50.34	50.45
43	50.55	50.66	50.77	50.87	50.98	51.08	51.19	51.30	51.40	51.51
44	51.61	51.72	51.82	51.93	52.04	52.14	52.25	52.35	52.46	52.56
45	52.67	52.77	52.88	52.98	53.09	53.19	53.30	53.40	53.51	53.61
46	53.72	53.82	53.92	54.03	54.13	54.24	54.34	54.44	54.55	54.65
47	54.76	54.86	54.96	55.07	55.17	55.27	55.38	55.48	55.58	55.69
48	55.79	55.89	55.99	56.10	56.20	56.30	56.41	56.51	56.61	56.71
49	56.82	56.92	57.02	57.12	57.22	57.33	57.43	57.53	57.63	57.73
50	57.84	57.94	58.04	58.14	58.24	58.34	58.45	58.55	58.65	58.75

TABLE IV.—*Per cents of alcohol by volume at 60° F., corresponding to various per cents by weight in mixtures of ethyl alcohol and water—Continued.*

Per cent alcohol by weight.	Tenths of per cent.									
	0	1	2	3	4	5	6	7	8	9
51	58.85	58.95	59.05	59.15	59.26	59.36	59.46	59.56	59.66	59.76
52	59.86	59.96	60.06	60.16	60.26	60.36	60.46	60.56	60.66	60.76
53	60.86	60.96	61.06	61.16	61.26	61.36	61.46	61.56	61.66	61.76
54	61.86	61.96	62.05	62.15	62.25	62.35	62.45	62.55	62.65	62.75
55	62.85	62.94	63.04	63.14	63.24	63.34	63.44	63.53	63.63	63.73
56	63.83	63.93	64.02	64.12	64.22	64.32	64.41	64.51	64.61	64.71
57	64.80	64.90	65.00	65.10	65.19	65.29	65.39	65.48	65.58	65.68
58	65.77	65.87	65.97	66.06	66.16	66.26	66.35	66.45	66.55	66.64
59	66.74	66.83	66.93	67.03	67.12	67.22	67.31	67.41	67.50	67.60
60	67.70	67.79	67.88	67.98	68.08	68.17	68.26	68.36	68.46	68.55
61	68.64	68.74	68.83	68.93	69.02	69.12	69.21	69.31	69.40	69.50
62	69.59	69.68	69.78	69.87	69.97	70.06	70.15	70.25	70.34	70.43
63	70.53	70.62	70.71	70.81	70.90	70.99	71.09	71.18	71.27	71.37
64	71.46	71.55	71.64	71.74	71.83	71.92	72.02	72.11	72.20	72.29
65	72.38	72.48	72.57	72.66	72.75	72.84	72.94	73.03	73.12	73.21
66	73.30	73.40	73.49	73.58	73.67	73.76	73.85	73.94	74.03	74.12
67	74.22	74.31	74.40	74.49	74.58	74.67	74.76	74.85	74.94	75.03
68	75.12	75.21	75.30	75.39	75.48	75.57	75.66	75.75	75.84	75.93
69	76.02	76.11	76.20	76.29	76.38	76.47	76.56	76.65	76.74	76.83
70	76.92	77.00	77.09	77.18	77.27	77.36	77.45	77.54	77.62	77.71
71	77.80	77.89	77.98	78.06	78.15	78.24	78.33	78.42	78.50	78.59
72	78.68	78.77	78.85	78.94	79.03	79.12	79.20	79.29	79.38	79.47
73	79.55	79.64	79.73	79.81	79.90	79.99	80.07	80.16	80.25	80.33
74	80.42	80.50	80.59	80.68	80.76	80.85	80.93	81.02	81.11	81.19
75	81.28	81.36	81.45	81.53	81.62	81.70	81.79	81.87	81.96	82.04
76	82.13	82.21	82.30	82.38	82.47	82.55	82.64	82.72	82.81	82.89
77	82.98	83.06	83.14	83.23	83.31	83.40	83.48	83.56	83.65	83.73
78	83.81	83.90	83.98	84.06	84.15	84.23	84.31	84.40	84.48	84.56
79	84.64	84.73	84.81	84.89	84.98	85.06	85.14	85.22	85.30	85.39
80	85.47	85.55	85.63	85.71	85.80	85.88	85.96	86.04	86.12	86.20
81	86.29	86.37	86.45	86.53	86.61	86.69	86.77	86.85	86.93	87.01
82	87.10	87.18	87.26	87.34	87.42	87.50	87.58	87.66	87.74	87.82
83	87.90	87.98	88.05	88.13	88.21	88.29	88.37	88.45	88.53	88.61
84	88.69	88.77	88.85	88.92	89.00	89.08	89.16	89.24	89.32	89.40
85	89.47	89.55	89.63	89.71	89.78	89.86	89.94	90.02	90.10	90.17
86	90.25	90.33	90.40	90.48	90.56	90.63	90.71	90.79	90.86	90.94
87	91.02	91.09	91.17	91.25	91.32	91.40	91.47	91.55	91.62	91.70
88	91.78	91.85	91.93	92.00	92.08	92.15	92.22	92.30	92.37	92.45
89	92.52	92.60	92.67	92.75	92.82	92.89	92.97	93.04	93.12	93.19
90	93.26	93.34	93.41	93.48	93.55	93.63	93.70	93.77	93.85	93.92
91	93.99	94.06	94.14	94.21	94.28	94.35	94.42	94.49	94.57	94.64
92	94.71	94.78	94.85	94.92	94.99	95.06	95.13	95.20	95.27	95.34
93	95.42	95.48	95.55	95.62	95.69	95.76	95.83	95.90	95.97	96.04
94	96.11	96.18	96.25	96.31	96.38	96.45	96.52	96.59	96.65	96.72
95	96.79	96.86	96.92	96.99	97.06	97.13	97.19	97.26	97.33	97.39
96	97.46	97.53	97.59	97.66	97.72	97.79	97.85	97.92	97.98	98.05
97	98.12	98.18	98.24	98.31	98.37	98.44	98.50	98.57	98.63	98.69
98	98.76	98.82	98.88	98.95	99.01	99.07	99.14	99.20	99.26	99.32
99	99.39	99.45	99.51	99.57	99.63	99.69	99.75	99.82	99.88	99.94
100	100.00									

TABLE V.—*Reduction of mixtures of ethyl alcohol and water from per cents by volume to per cents by weight.*

Per cent alcohol by volume at 60° F.	Per cent alcohol by weight.	Differ-ences.	Per cent alcohol by volume at 60° F.	Per cent alcohol by weight.	Differ-ences.	Per cent alcohol by volume at 60° F.	Per cent alcohol by weight.	Differ-ences.
0	0.00	0.80	34	28.10	0.87	68	60.32	1.06
1	0.80	.79	35	28.97	.87	69	61.38	1.06
2	1.59	.80	36	29.84	.88	70	62.44	1.07
3	2.39	.81	37	30.72	.87	71	63.51	1.07
4	3.20	.80	38	31.59	.89	72	64.58	1.09
5	4.00	.80	39	32.48	.88	73	65.67	1.09
6	4.80	.81	40	33.36	.89	74	66.76	1.10
7	5.61	.81	41	34.25	.90	75	67.86	1.12
8	6.42	.81	42	35.15	.89	76	68.98	1.12
9	7.23	.82	43	36.04	.91	77	70.10	1.13
10	8.05	.81	44	36.95	.91	78	71.23	1.14
11	8.86	.82	45	37.86	.92	79	72.37	1.15
12	9.68	.82	46	38.78	.91	80	73.52	1.16
13	10.50	.82	47	39.69	.93	81	74.68	1.17
14	11.32	.82	48	40.62	.92	82	75.85	1.18
15	12.14	.82	49	41.54	.94	83	77.03	1.19
16	12.96	.82	50	42.48	.94	84	78.22	1.21
17	13.78	.83	51	43.42	.95	85	79.43	1.22
18	14.61	.83	52	44.37	.95	86	80.65	1.23
19	15.44	.83	53	45.32	.95	87	81.88	1.25
20	16.27	.83	54	46.27	.97	88	83.13	1.27
21	17.10	.83	55	47.24	.96	89	84.40	1.28
22	17.93	.83	56	48.20	.98	90	85.68	1.30
23	18.76	.84	57	49.18	.98	91	86.98	1.32
24	19.60	.84	58	50.16	.99	92	88.30	1.34
25	20.44	.84	59	51.15	.99	93	89.64	1.37
26	21.28	.84	60	52.14	1.00	94	91.01	1.40
27	22.12	.85	61	53.14	1.00	95	92.41	1.43
28	22.97	.85	62	54.14	1.02	96	93.84	1.47
29	23.82	.85	63	55.16	1.02	97	95.31	1.51
30	24.67	.85	64	56.18	1.02	98	96.82	1.56
31	25.52	.86	65	57.20	1.03	99	98.38	1.62
32	26.38	.86	66	58.23	1.04	100	100.00	
33	27.24	.86	67	59.27	1.05			

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